agricultural research

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Raising Biological Ceilings

Science and technology offer the best hope for feeding the world's burgeoning population over the coming decades. The bountiful harvests achieved through modern agricultural technologies—mainly based upon generous and skillful use of chemicals, machines, irrigation, and conventional genetics—are beginning to level off as crops and farm animals reach their natural productive limits. If U.S. farmers are to continue feeding their fellow citizens while producing a surplus for a hungry world, they will have to exploit the discoveries of tomorrow. Indeed, the well-being of mankind may hinge on the outcome of various imaginative experiments aimed at overcoming present biological limits to food production.

A prime example of such research concerns photosynthesis, upon which the productivity of the earth depends. In photosynthesis, the chlorophyll of leaves, powered by sunlight, turns carbon dioxide and water into the sugars that ultimately nourish all life. Unfortunately, the average leaf captures and fixes scarcely 1 percent of incoming solar energy in photosynthetic reactions. Moreover, there are great disparities in the efficiency of photosynthesis. Some high-yielding crop plants—corn, sorghum, and sugar cane, for example—make modestly efficient use of carbon dioxide in producing food. But such important crop plants as wheat, soybeans, and rice are only about 50 percent as efficient. After transforming carbon dioxide into energy-rich sugars, these plants then change nearly half the sugars back into carbon dioxide and heat. This loss of carbon dioxide—a waste of energy—occurs through a process called photorespiration; it is just the opposite of photosynthesis. If photorespiration could be inhibited, the yields of wheat and soybeans, which in 1974 averaged 28 and 24 bushels per acre respectively, might be raised by upwards of 50 percent.

Agricultural scientists are exploring various methods of improving the efficiency of photosynthesis. These include finding chemicals that inhibit photorespiration, redesigning the geometrical arrangement of a crop plant's leaves to trap more sunlight, and breeding new and superior plants, not by the conventional breeding of parent plants, but through an experimental method of fusing single cells. Success may be some time away. But when these or other approaches to improving photosynthesis succeed, simply by harnessing more sunlight and carbon dioxide, they will significantly "add" to the resources of the earth, and mark a great advance toward adequately feeding mankind.

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COVER: Snow, the source of most of the available water in the western United States, is under extensive study by ARS researchers at the Northwest Watershed Research Center, Boise, Idaho. Hydrologist Lloyd M. Cox uses a snow tube to measure the depth and density of a snow field (0675X802–11). Article begins on page 8.

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Plant pathologist Lawrence R. Schreiber with the parent Urban elm, from which all the propagative material for other Urban elms has been taken (0574X720–7A).

The stately elm returns

STATELY ELM TREES that once adorned America's streets, parks, and lawns in large numbers from the Great Plains to the Atlantic coast may be on their way to making a comeback. A hybrid, named "Urban elm," will be available in limited supply in about 3 years. It is resistant to Dutch elm disease which has spread throughout the American elm's natural range since the 1930's.

Scientists at the ARS Shade Tree and Ornamental Plants Laboratory, Delaware, Ohio, developed Urban elm from a cross between an elm from the Netherlands (*Ulmus hollandica* var. *vegeta X Ulmus carpinifolia*) and a Siberian elm. "We expect the new tree will grow to moderate size, making it more suitable for urban planting than the American elm," says plant pathologist Charles L. Wilson. Like the American elm, the new hybrid grows fast in various soil types, has dark green foliage, and is tolerant to drought, pollution, soil compaction, and restricted root space.

In the fall, Urban elm offers the promise of a striking appearance, Dr. Wilson says, because at many locations where it is adapted, the tree retains its foliage and dark green color longer than other trees. The new hybrid has a profuse upright branching habit and its dense foliage produces a compact crown.

A team began developing Urban elm in 1956, crossing parent trees to obtain seedlings that proved capable of withstanding inoculations of the fungus, *Ceratocystis ulmi*, which causes Dutch elm disease. Then came years of propagation and seasonal susceptibility trials in which plants grown from cuttings were inoculated with strains of fungi at various times of the year.

Research technician Harold Main twig grafts scions from the parent Urban elm onto Siberian elm root stock. Siberian elm stock is chosen because of its resistance to Dutch elm disease and compatibility for grafting with the Urban elm scions (0574X722–10).

For the past 2 years, under an agreement with ARS, wholesale nurserymen have been testing the tree further for adaptability to various climatic conditions. The agreement prescribes that the nurserymen propagate the elms in sufficient numbers to insure that they will be available to other nurserymen before commercial trade begins.

ARS plant scientists at the Delaware laboratory are developing more hybrid elms that may be released within a few years. "We have about six different elm selections including two American elms that have moderate to high resistance to Dutch elm disease," says plant pathologist Lawrence R. Schreiber.

Plant geneticist Alden M. Townsend says that physical characteristics vary substantially among elms in the breeding program. Some could be made into shrubs. Others may grow from seed to heights of 15 feet within 3 years. "We have crossed a Chinese elm, which has a deep red coloration, with a columnar shaped elm," Dr. Townsend said. This tree might be used to replace Lombardi poplar which is susceptible to cankers and may die within about 8 years after planting. □

Although the Urban elm may be thought of as a replacement for the American elm because of its resistance to the Dutch elm disease, researchers emphasize that it will not serve as a substitute planting in the same situations. As the diagram shows, the new tree is smaller and has an upright branching form in contrast with the well-recognized umbrella shape of the American elm. Although a fully-mature Urban elm will not be available for several years, scientists anticipate that it will grow to a height of 60 to 80 feet (PN–4106).

Combating Dutch elm disease

THE FOCUS of research to combat Dutch elm disease extends beyond breeding resistant varieties of trees. Existing elms are still threatened. Scientists want to help prevent further damage from the disease which has already caused more than $1 billion in losses in the United States.

ARS scientists at the Shade Tree and Ornamental Plants Laboratory found that a solubilized derivative of the fungicide benomyl is effective against the disease in experimental treatments of trees. This form of the fungicide, as yet not registered for this use, is injected as a solution directly into trees.

The scientists are now studying ways of improving their pressure injection technique for using this chemical or others as they become registered.

Scientists of USDA's Forest Service, Delaware, Ohio, and the State University of New York College of Environmental Science and Forestry, Syracuse, have isolated, identified, and artificially synthesized the sex attractants of the elm bark beetles which spread Dutch elm disease. The potential of mass trapping elm bark beetles at attractant-baited traps for reduction of beetle populations and suppression of Dutch elm disease incidence is now being evaluated.

New chromobacterium reported on broilers

An organism never before reported on processed poultry has been isolated and identified as *Chromobacterium lividum*.

Microbiologist Nelson A. Cox, Richard B. Russell Agricultural Research Center, Athens, Ga., observed these bacteria during routine microbiological research on eviscerated broiler carcasses obtained for experimental purposes from a commercial processing plant in Georgia. The carcasses were fresh and stored at 2° C until spoilage.

Violet pigmented colonies comprised 2 to 5 percent of the colonies on all of the standard methods agar plates incubated 72 hours at 20° C. Several colonies were transferred from the countable agar plates to brain heart infusion broth, a widely used nutrient that allows many kinds of bacteria to grow. The organism was then subjected to a variety of tests for identification.

Chromobacterium is a large gram-negative rod (gram-negative bacteria do not hold crystal violet dye when stained) which produced a tough, rubbery, violet pellicle of growth at the surface of the infusion broth. A slimy texture was observed when colonies were picked from the nutrient agar. Soluble in ethanol, the purple pigment was insoluble in water or chloroform.

"These soil and water organisms occasionally cause infections of mammals or food spoilage, according to Bergey's *Manual of Determinative Bacteriology*," said Dr. Cox. They grew profusely at 20° C and at 25° C—room temperature—after 24 hours; slightly at 4° C—normal supermarket refrigerator temperature—after 7 days; but not at all at 37° C—body temperature—after 7 days.

The significance of the previously unreported genus from poultry is as yet unknown. □

Minimizing postharvest blueberry losses

A brief hot water treatment teamed with water handling during cleaning and sorting at the receiving station can minimize postharvest disease losses in blueberries.

A 2½- to 3-minute exposure to 120° F water gave maximum yield of marketable fruit in tests by plant pathologist Clyde L. Burton and agricultural engineers Bernard R. Tennes and Jordan H. Levin, East Lansing, Mich.

This treatment controlled botrytis, rhizopus, and alternaria rots, the principal diseases of berries held for processing or the fresh fruit market. A 1- to 1½-minute exposure at 125° F also controlled anthracnose rot.

Dr. Burton says decay usually develops within 24 hours under warm, humid conditions in fruit that contains rot-contaminated berries. In one series of tests, however, the proportion of marketable berries was tripled by the most effective hot water treatments, in comparison with no treatment. After treatment, the fruit was held 9 days at 36° F to simulate transit and storage, and then 4 days at 68° F to stimulate a marketing period.

Most Michigan blueberries are now harvested mechanically, and they usually are acceptable for the fresh market as well as for processing. Presently used pneumatic sorting and cleaning, however, damages the fruit and increases disease contamination. At times, the quality of cleaned fruit is so poor it is rejected for processing.

The researchers believed that water handling, already used in cleaning and sorting other produce, might reduce damage to blueberries if two difficulties could be overcome.

Water, like the pneumatic cleaner, might spread disease organisms and increase infection of the fruit. Hot water treatment, however, had been used by other researchers to control postharvest decays of fruits and vegetables and could be incorporated in a water handling system.

Berries are also hard to dry, and free moisture on the fruit would favor disease development. The engineers devised a drying and cooling procedure in which excess moisture is stripped from the fruit, as it is conveyed out of the hot water, by jets of air. The fruit then tumbles gently onto a wire mesh drying and cooling line where fans help remove the remaining free moisture and cool the fruit to near room temperature before it falls into containers.

The researchers evaluated a semicommercial water handling and treatment system with a capacity of 250 pounds of blueberries per man-hour at a South Haven, Mich., receiving station. Removal of trash, separation by size, sorting, dipping in hot water, and drying and cooling are part of the system, which is automated except for final sorting.

The South Haven test compared water temperatures of 110°, 115°, 120°, 125°, and 130° F, each at five exposure times ranging from 1 to 3 minutes.

The minimum combination to significantly increase the percentage of good fruit was at least 2 minutes at 115° F for mechanically harvested blueberries held 24 hours after harvest. For blueberries treated shortly after harvest, 110° F for 1½ minutes was the minimum effective treatment. Four other temperature-time combinations, at 120° and 125° F, gave good or maximum yields of acceptable fruit when treatment was delayed 24 hours. □

Clean stored grain with . . .
A beneficially destructive pathogen

The effectiveness of the pathogen treatment is evident when untreated grain (below, 0575X578–9) and treated grain (above, 0575X578–10) are compared. The untreated sample also illustrates that the damage done by the Indian meal moth is, for the most part, restricted to the surface of stored grain.

A MINUTE AMOUNT—about 2 parts per million—of an insect pathogen effectively controlled the Indian meal moth in wheat and corn in preliminary laboratory experiments.

The pathogen, a granulosis virus, is thought to act by inhibiting only unique aspects of the target insect's physiology. The virus affects cells of the epidermis, fat, trachae, and perhaps other tissues of Indian meal moth larvae.

Demonstration of its potential as a biological alternative to insecticides is a significant step toward safer, more effective protection of stored grain and grain products. ARS entomologist William H. McGaughey points out that the Indian meal moth, a serious pest, is difficult to control because of its resistance to malathion and synergized pyrethrins.

His studies at the U.S. Grain Marketing Research Center, Manhattan, Kans., extend earlier findings of ARS entomologist Douglas K. Hunter, Fresno, Calif. Dr. Hunter and associates showed that the granulosis virus would protect unshelled nuts against the Indian meal moth (AGR. RES., Jan. 1973, p. 13).

Dr. McGaughey found that the granulosis virus, formulated from diseased larvae produced in the laboratory, was equally effective when applied to grain as an aqueous suspension or as a dust mixed with wheat flour. The formulation contained about 32 million virus capsules per milligram.

His laboratory experiments suggest that the Indian meal moth can be controlled by two or three applications of the aqueous formulation sprayed on the surface of stored grain. The surface would then be raked or mixed with a garden rake or hand scoop. Such mixing, if done thoroughly, should provide adequate coverage and depth.

A slight increase in the 2 parts per million (ppm) dose might be needed, Dr. McGaughey says, if adequate depth of incorporation is not feasible. He believes the cost of such an increase should be more than offset by the large savings from treating only the surface layer of grain already in storage. Turning the grain for bulk treatment may be impractical.

Dr. McGaughey evaluated use of the granulosis virus on wheat and corn stored in containers ranging in size from jars holding slightly more than 4 quarts to metal columns about 6 inches in diameter and 4 feet high. He placed Indian meal moth eggs on the treated grain, then held the containers in a controlled environment for mortality determinations after adults emerged.

After confirming the effectiveness of the virus in protecting grain, Dr. McGaughey conducted a series of experiments to compare alternate methods of applying the aqueous formulation.

The Indian meal moth tends to infest only the surface layer of grain stored in bulk, he explains. Simpler equipment and less pathogen would be required if only the grain subject to infestation need be treated. He therefore compared treating the surface layer to different depths, treating half the grain and mixing it with the remainder, and treating all of the grain.

Dr. McGaughey found little difference whether the treatment was concentrated in the upper layer, applied to part, or to all of the grain. He concluded that application need not be particularly uniform, as has often been required in field use of microbial insecticides. He says slightly higher doses may be necessary when only the surface

Above: Research technician Edwin B. Dicke applies the pathogen to a small sample of grain. The treatment achieved 100 percent kill of Indian meal moth eggs in comparison to an untreated sample in which 95 percent of the eggs remained viable (0575X577–35). ***Below:*** *Dr. McGaughey observes as the pathogen is mixed into grain samples which are then used to "top-off" the 4-foot high simulated grain bins in another test (0575X577–18).*

layer is treated. A treated layer about 4 inches deep gave good control at the 2 ppm application rate.

Dr. McGaughey also found that uniform application of the virus to kernels of grain within the treated layer probably was unnecessary. When the treated kernels were evenly distributed through the layer, Indian meal moth mortality was almost identical whether 10, 50, or 100 percent of the kernels in the layer were treated. □

Impregnating seeds with chemicals

CHEMICALS that speed or delay seed germination or prevent deterioration during transport, storage, and germination can now be efficiently introduced into dry seeds under research laboratory conditions.

Ordinarily, chemicals dissolved in water or applied as dry powders are used for seed treatments. These procedures are unsatisfactory, however, if the purpose of the treatment is to introduce chemicals into seeds before the start of germination. Water absorption and the start of germination begin before diffusion can carry the chemicals to critical sites inside the seed. The active ingredient of most dry powders does not penetrate the seed coat.

Now, Israeli scientists have found that chemicals can be introduced into dry seeds with the aid of nonwater solvents, such as dichloromethane and acetone.

Immediate implementation of the Israeli finding has resulted in successful use of acetone as a carrier for fungicides and insecticides in the treatment of dry seeds prior to planting. These experiments were conducted by plant physiologist Anwar A. Khan, microbiologist Gary Harman, entomologist Charles Eckenrode, and their colleagues at the New York State Agricultural Experiment Station, Geneva, on lettuce, cucumber, pea, lima bean, and other seeds.

ARS-cooperating scientist Lowell W. Woodstock, Beltsville, Md., says the ability to achieve deep penetration of seeds with germination-stimulating chemicals, such as gibberellins and kinetins, or with germination-inhibiting chemicals, such as abscissic acid, has great practical implications.

"For example," he says, "seeds could be made dormant with inhibitors prior to storage to prevent sprouting under moist conditions. This dormancy might also slow down the deteriorative processes. After storage and before planting, the inhibitor(s) might be removed and germination-promoting chemicals added to promote rapid and uniform sprouting."

Also, many fungicides and insecticides are readily soluble in dichloromethane and acetone. Once inside the seeds, such fungicides and insecticides, which are only slightly soluble in water, will not be washed away when the seeds are planted. Bacterial and viral controlling chemicals, such as the antibiotics chloramphenicol and puromycin, may also be introduced into the seeds with nonwater solvents.

The Israeli project has given new insights into the nature of seed enzyme activation during the germination process. The scientists proved that dry seeds contain a large number of readymade enzymes—as opposed to the view that a seed must first synthesize *all* its enzymes. "The activation of seed enzyme systems," Dr. Woodstock says, "can be described as analogous to a computer system, in that it involves a complex interplay of sequential chemical reactions. Introduction of selected chemicals into dry seeds enhances the potential of programing these systems for improved growth, yield, and disease resistance."

The Israeli project was directed by Dr. A. M. Mayer and Dr. A. Poljakoff-Mayber at the Hebrew University of Jerusalem. □

Nature's reservoir

Summer's water from

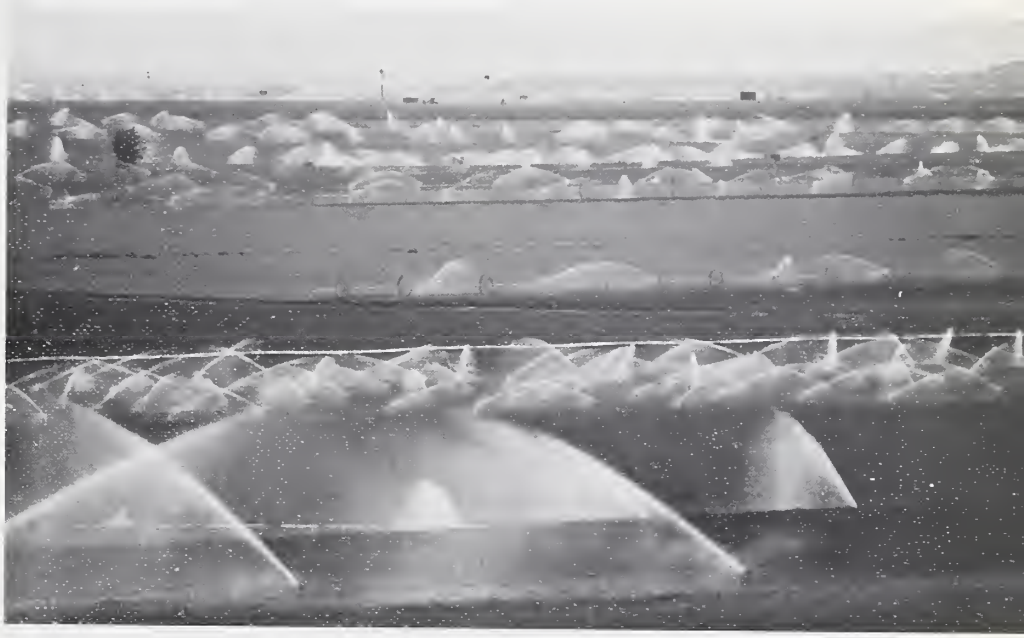
Snowpack in the Reynolds Creek watershed lies on the hills like marshmallow topping on a sundae (0675X802–11).

THERE IS great concern today that natural resources be properly managed to minimize waste and inefficiency. Many parts of the world are blessed with a natural resource of tremendous potential that requires no excavating or drilling to use. ARS is learning how to best manage this resource—snow.

Snow is one of nature's greatest reservoirs. It is the source of most of the usable water in the western United States. Water derived from snow, which finds its way into streams, lakes, and reservoirs in the spring and early summer, is the lifeblood of the Western economy.

Determining the quantity of water stored in snow and the timing of the water's release are important to the development and management of this resource. Reliable forecasts are necessary to make sound management decisions involving irrigation, stock water and municipal water supplies, hydropower generation, recreation, naviga-

Left: An ARS hydrologist on an early June inspection trip is dwarfed by a snowfield in the Reynolds Creek watershed. Hydrologists have found that late spring snowmelt is produced equally by both direct sunlight and heat from overlying air—important knowledge in predicting the amount of available water from the snowmelt (0675X801–32). Below: Spring snowmelt, stored in reservoirs and lakes, eventually becomes the lifegiving irrigation water for summer crops in western Idaho (0675X803–32A).



winter's snow

tion, and pollution control.

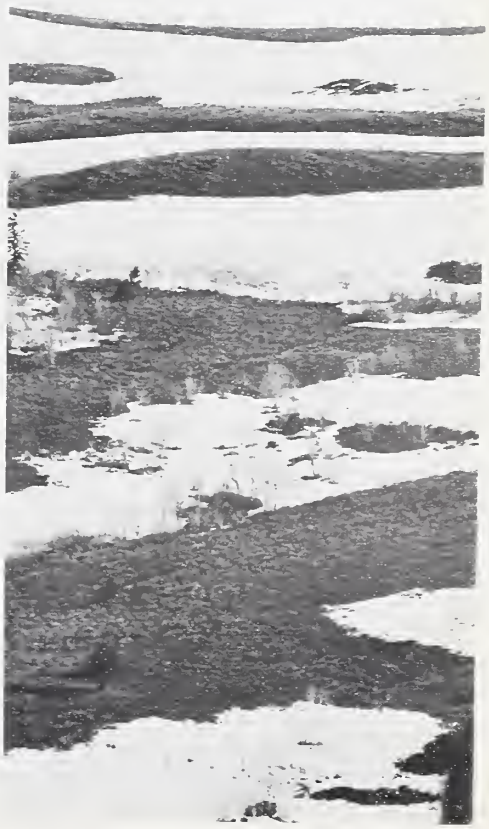
Forecasts are being made now, but these forecasts are less than accurate. For example, by using data on snowpack water from over 1,200 sites, the annual flow of the Columbia River at the Dalles in Oregon, can be estimated. This estimate of snowmelt water supply, however, is in error by about 12 percent. Improving the estimate by even 1 percent, could return over $6.2 million annually from improved power production and irrigation management alone.

The Northwest Watershed Research Center, Boise, Idaho, is presently conducting intensive investigations to learn how to minimize evaporation losses from snowpacks, to maximize and prolong water yield from snow, and to improve short-term and long-term snowmelt predictions and water supply forecasts.

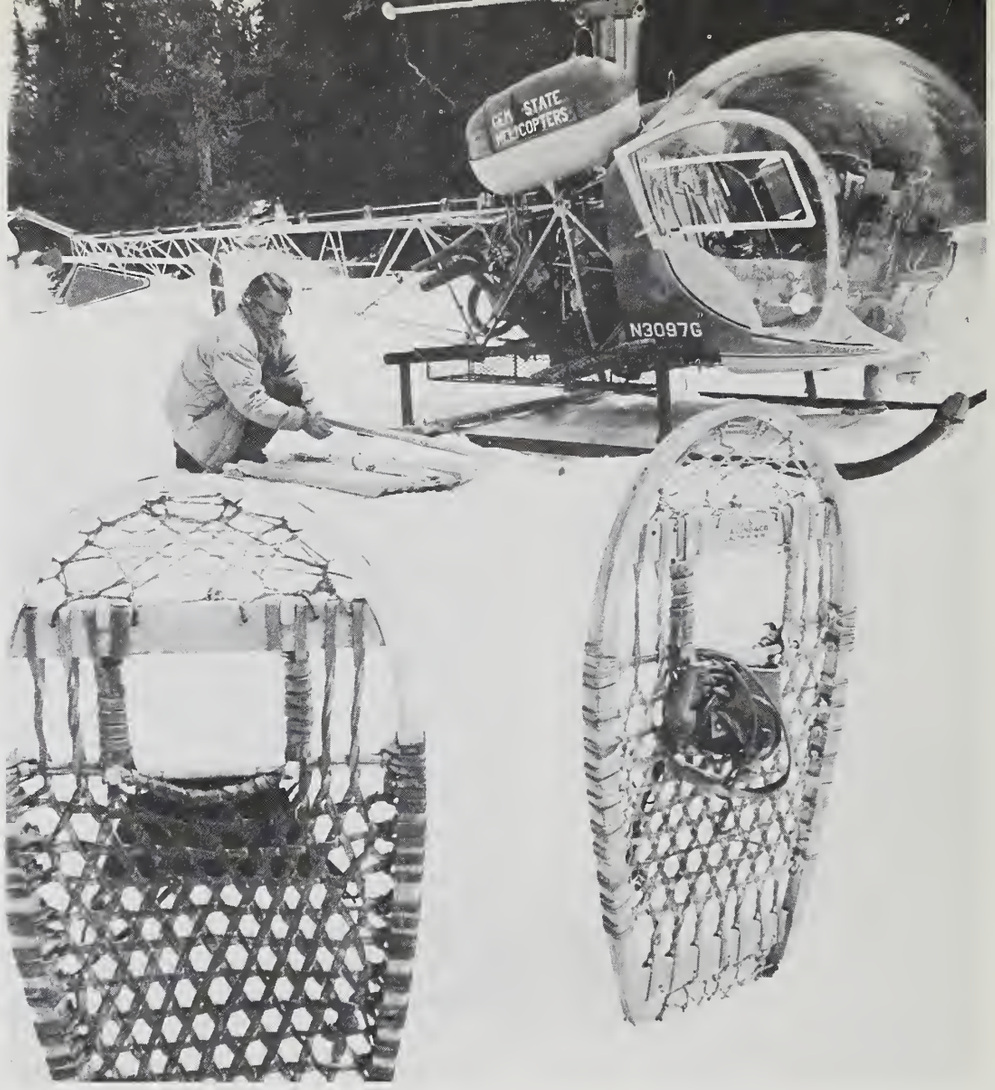
This ARS effort is conducted by hydrologists Lloyd M. Cox, Walter J. Rawls, and John F. Zuzel, of Boise. Their field research, which takes place on a vast expanse of sagebrush rangeland, southwest of Boise, called the Reynolds Creek Watershed, is done cooperatively with USDA's Soil Conservation Service (SCS) on the 2,650 square mile Boise River Watershed east of Boise. A watershed is an area of land that catches precipitation and feeds it into a water body.

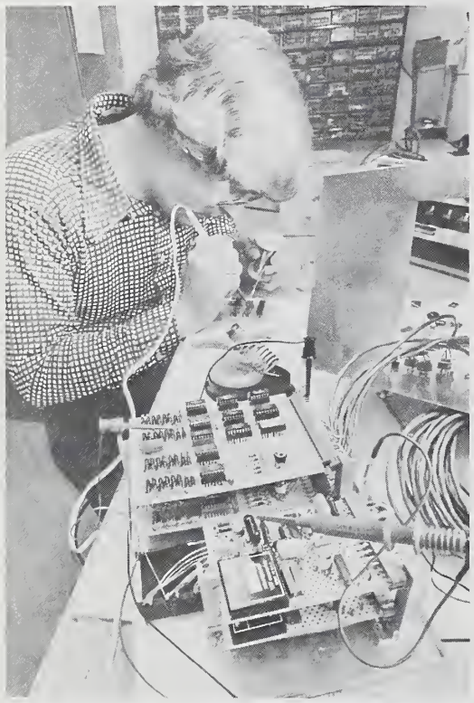
The first step in forecasting snowmelt water supply is to measure snowfall. Currently, most forecasters use rain gages to make the measurement, but wind can cause as much as an 80-percent error when using these unshielded catches for snow. By using two recording rain gage catches simultaneously, one gage shielded, the other unshielded, the ARS team adjusted observed precipitation values to give a better estimate of actual values. This dual rain gage network reduced the wind error for snow to less than 10 percent.

Since every snowdrift functions as a



Scientific observations on snowmelt are made in some of the watershed's most inaccessible regions. Technician Mike Burgess assembles electronic equipment used in some cases to transmit digitized snowmelt and runoff data back to the research center in Boise (0675X804–15). In most cases, however, inaccessible regions are reached by helicopter. But where transmitter or helicopter cannot go, "shanks mare" must do. Dr. Cox checks his snow survey instruments before donning snowshoes to hike into the remote back country of the Trinity Mountains (0675X805–36).





Collected from the weir in the background, the water samples held by Dr. Cox will be analyzed to determine water quality and sedimentation. The weir is one of several constructed to aid scientists in precisely measuring the amount of waterflow during spring runoffs (0675X801–8).

small reservoir, supplying water over a period of time, it is important to determine the size, shape, and location of snowdrifts. The ARS team is using aerial photography to measure snowdrifts over a watershed. The technique is similar to procedures used in mapmaking and has shown that on sagebrush rangeland at least 66 percent of the annual snowfall is stored on less than 30 percent of the watershed land area.

Traditionally, measuring weather variables for snowmelt forecasting has meant recording the temperature only. Studies indicate that forecasting could be improved 13 percent by measuring vapor pressure, net allwave radiation, and wind, instead of temperature alone.

Temperature is still important. The rate at which a snowpack will melt depends upon the amount of heat it receives. Heat may be added to a snowpack from several different sources. Early in the year when continuous snow cover is present, most snowmelt is caused by direct sunlight. Later in the season, when isolated, latelying drifts are present, snowmelt is produced equally by both direct sunlight and heat from the overlying warm air. These factors affect the length of time snow water will be available to add to the flow of the waterbody receiving watershed runoff.

A unique relationship exists between daily snowmelt and watershed runoff for a given snowmelt event. On the Boise River, ARS has used this relationship to forecast, 1 day in advance, streamflow of the recipient waterbody to within 10 percent of the waterbody's daily flow.

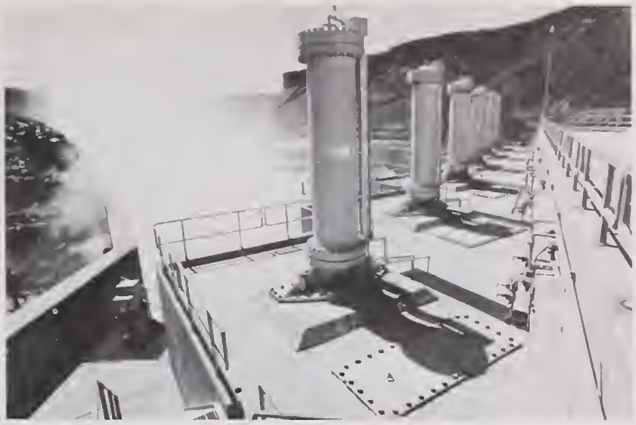
For long-term streamflow forecasting on the Boise River, the researchers developed an optimization technique that minimizes runoff volume errors for specific forecast periods. Results indicate that this optimization technique effectively increases forecasting ac-

Rain gages that automatically weigh and record collected precipitation are used in tandem—one shielded, the other unshielded—for greater accuracy in the watershed study. Here, Dr. Cox inspects a gage at one of the 50 sites spread across the high prairie (0675X801–15A).

curacy by 5 percent over conventional forecasting models.

The researchers are now gearing up to improve forecasting techniques by using daily data collected by satellite. Two Land Sat I (formerly ERTS–1) data platforms are being obtained cooperatively from the National Aeronautics and Space Administration (NASA) for collecting hydrometeorological data from snowpacks in the Boise River Watershed. Boise River flows are currently being obtained by this same system through a cooperative venture with the Idaho Department of Water Resources.

Man will probably never devise a water storage system with as much capacity and with such a desirable location as snow. By assessing snow volumes, snow water content, snow evaporation, and snowmelt over a watershed, ARS hopes to tap this natural resource in a way that will most benefit urban and rural dwellers. □



***Above:** Spring snowmelt waters thunder through the Lucky Peak Dam into the Boise River below (0675X807–3). **Below:** Along another stretch of the Boise River snowmelt is stored in the Anderson Ranch Reservoir. Predicting accurately the spring snowmelt enables better use of water for irrigation and hydroelectric power (0675X805–25).*

While dairy cattle with clinically apparent paratuberculosis (above) can be culled by dairymen, losses among cattle having the clinically inapparent paratuberculosis can increase the cost of the disease in dairy herds (PN–4107).

Paratuberculosis: a threat to dairy cattle

Dr. Larson opens the intestinal tract of a diseased animal during a gross post-mortem examination to isolate the area containing the paratuberculosis organism (0675X707–33).

PARATUBERCULOSIS probably is a much more costly disease in dairy herds than is generally recognized.

Losses usually are estimated in terms of shortened life expectancy and the reduced production and slaughter value of clinically ill cattle. In England, paratuberculosis (Johne's disease) is considered the most economically important infectious disease of cattle.

Losses among dairy cattle having paratuberculosis that has gone undetected (clinically inapparent) could increase the cost of the disease as much as 75 percent in some dairy herds, studies by scientists at the National Animal Disease Center, Ames, Iowa, have suggested.

Significantly higher percentages of cows with inapparent paratuberculosis were culled because of mastitis and infertility by the owner of a large dairy herd under study, in comparison with noninfected cattle. ARS microbiologist Richard S. Merkal says *Mycobacterium paratuberculosis* infection may increase susceptibility to mastitis. Another possibility is that animals genetically or consitutionally more susceptible to paratuberculosis may also be more susceptible to mastitis.

Dr. Merkal, ARS veterinary medical officer Aubrey B. Larsen, and statistician Gordon D. Booth conducted the study in an infected herd of 900 to 950 dairy cows born between 1951–72. An association of inapparent paratuberculosis with mastitis and infertility would be highly important to dairymen, they point out, because these are the two most important reasons for culling animals in most dairy herds.

The scientists recorded the reasons given by the owner for culling and, beginning in 1963, periodically identified infected cows by culturing fecal samples from adult cattle or tissue samples at slaughter. Until 1968, the researchers did not advise the owner which cows were infected until after culling and slaughter.

Clinically apparent paratuberculosis was the owner's reason for culling 29.9 percent of the infected cows during the study. No animals born during the last 4 years, when the owner received imme-

diate reports of infection, have developed the clinically apparent form of the disease.

Mastitis was the reason for culling 22.5 percent of the paratuberculous cows that had not previously been removed as clinically ill. Only 3.6 percent of the cows testing free of paratuberculosis were culled because of mastitis.

Infertility was the owner's reason for removing 68.8 percent of the infected and 60.2 percent of the noninfected cattle not culled because of clinically apparent paratuberculosis or mastitis. No meaningful differences between infected and noninfected cattle were associated with other reasons for culling.

During the first 8 years, the owner moved cows ready to calve to a "hospital pasture" for sick cattle and held them there until calves were delivered and appeared to be in satisfactory conditions. The infection rate was 35.2 percent of the cows tested, and 11.9 percent of the cattle born during the 8 years were culled because of elinical paratuberculosis.

The researchers then advised use of separate, clean pastures for calving, and that the calves receive colostrum for 1 day or less and then be raised separately from the older animals. With adoption of these recommendations, the rate of infection dropped to 9.9 percent and the rate of clinical illness to 3.4 percent of cattle born in the second 8 years. Too few animals born in the last 4 years of the study have reached maturity and been culled to draw definite conclusions on infection rate in this period.

Dr. Merkal says the rate of clinical illness is high, and eattle die relatively young if calves are allowed to nurse for extended periods where they are exposed to cattle shedding the bacillus. Of 114 paratuberculous cows culled during the study, for which the infection status of their dams was known, nearly 75 percent were born of noninfected dams. This high percentage is evidence of the high rate of cross-contamination, he says. □

Ingenuity, automation enhance meat research

You are a research chemist studying the aging of meat during storage. Emerging from your chromatographic column is an enzyme preparation on which you have to make several simultaneous analyses every 5 minutes or so, day and night, for at least a week. Since you and your small staff work only 8 hours a day, and your laboratory is not a 24-hour-a-day operation, your problem obviously calls for some imaginative automation.

You know the manufacturers of scientific instruments could readily build an automatic device to meet your specifications, but there are no funds available for such a solution. What do you do?

This is no hypothetical problem. It was faced a year or so ago by ARS ehemist Samuel M. Mozersky, who is doing research on myosin, the muscle protein, at the Eastern Regional Research Center, Philadelphia, Pa. The aging of meat during storage is presumably reflected in changes that occur in the properties of myosin. Dr. Mozersky was interested in following, over a period of as long as a couple of weeks, the protein content and the enzymatic activity of myosin preparations made from stored meat samples.

Dr. Mozersky consulted with another research chemist who is an electronics specialist as well, Joseph A. Connelly. Together they produced a homemade, low-cost monitoring system capable of making all the needed tests automatically and simultaneously, and recording the data on a perforated tape that can be fed into a computer for analysis.

The scientists started with a spectrophotometer that takes readings of the effluent from the chromatographic column at four different wavelengths. The wavelength wheel of the spectrophotometer can be set to make the wheel stop at any desired wavelength. In operation, the wheel advances continuously, being stopped only at the preselected wavelengths where readings are taken. For Dr. Mozersky's myosin, four readings were needed to give an accurate analysis of the protein present.

When this analysis of the protein is complete, the apparatus provides for a portion of the effluent to be drawn off with a stream splitter. This portion is automatically brought into contact with ATP (adenosine triphosphate) which serves as a substrate for the enzyme and other reagents. Another spectrophotometer measures the absorbance of the product of this reaction. The results are recorded on the tape along with the results for protein content.

The apparatus includes eight channels for recording analytical results, only five of which Dr. Mozersky actually uses in his study of myosin. Thus three others are still available for recording other information, such as pH and conductivity. A simple modification would double the number of channels available.

Meat research at the Eastern Regional Research Center is receiving a boost from imaginative linkage of many existing apparatuses to perform a particularly demanding analytical task. The system is applicable, not only to meat studies, but to amino-acid analysis and to any other research where multiple, simultaneous ehromatographie analyses are required. □

Darby selected as Atwater Lecturer

WILLIAM J. DARBY, president of the Nutrition Foundation, Inc., New York, N.Y., will present the seventh W. O. Atwater Memorial Lecture in San Antonio, Tex., on October 21, 1975.

ARS will present this year's Atwater lecture in cooperation with the American Dietetic Association. The agenda of their 58th annual meeting will cover an assay of current trends and developments in nutrition research, education, management, and legislation.

Established by ARS in 1967 in honor of Dr. Wilbur Olin Atwater (1844–1907), the Atwater lectureship gives special recognition to individuals who have made outstanding contributions in a field of science broadly related to human nutrition and world food needs. Dr. Atwater was USDA's first Chief of Nutrition Investigations, appointed in 1894. He built the first U.S. calorimeter for measuring the energy value of foods and in 1896 compiled the first extensive tables of food values published in the United States.

Dr. Darby is an internationally recognized authority on nutrition education and research and its administration. For more than 25 years he has been a leader in the biochemistry and nutrition programs at the Vanderbilt University School of Medicine, Nashville, Tenn.

Dr. Darby pauses during some work in his laboratory at the Vanderbilt University School of Medicine (0675X757–30A).

Since 1971 he has been president of the Nutrition Foundation, Inc., where he has continued, on a broader basis, to direct and coordinate nutrition research and education.

The foundation was established in 1941 by academic and industrial leaders who saw the need for an institution that would support basic research, developments, and education in the field of nutrition. Through the years the foundation's role has altered and expanded in response to assessed needs and opportunities to promote public good and human betterment.

Over the last three decades Dr. Darby has served on many national and international committees and has been particularly active in advisory groups serving the World Health Organization, the Food and Agriculture Organization, the Interdepartmental Committee on Nutrition for National Development, National Academy of Sciences, Department of Health, Education, and Welfare, Environmental Protection Agency, the American Medical Association, Office of the Surgeon General of the Army, and USDA.

Dr. Darby has authored or coauthored more than 150 scientific articles, reviews, books, and reports on subjects related to his discipline as a clinical physician and medical administrator. He holds numerous national and international awards in recognition of his accomplishments in the fields of nutrition and biochemistry.

Born in Galloway, Ark., Dr. Darby received his medical degree from the University of Arkansas, Little Rock, in 1937 and his Ph. D. degree in biological chemistry from the University of Michigan, Ann Arbor, in 1942. □

AGRISEARCH NOTES

Rootworms and rainwater

THE CORN PLANT'S system of "gutters and downspouts" that makes it an efficient rainwater collector also invites corn rootworm egg laying.

Corn varieties that are more efficient in collecting rain will attract more egg laying in dry weather, says ARS entomologist Vernon M. Kirk, Northern Grain Insects Research Laboratory, Brookings, S. Dak.

During the week after a 2.03-millimeter (0.08-inch) rain in September 1974, Dr. Kirk found an average of 8.7 rootworm eggs in moist soil at the roots of 10 corn plants but only an average of 0.5 eggs near 10 plants in dry soil. The plots in this preliminary study were in a field of mixed hybrids.

Dr. Kirk had established the plots by measuring the areas of moist soil at the bases of plants after a light rain and marking efficient and inefficient rain collectors. He marked 25 plants in each group.

He also measured and calculated the areas of those parts of corn leaves that would drain water toward the stalk. The water-collecting surfaces of leaves vary among both plants and varieties.

Only 0.5 millimeters (mm) of precipitation fell during the month before the 2.03 mm rainfall. Four hours after the rain, the more efficient rain-collecting corn plants had a band of moist soil around their roots that was as much as 25 centimeters (10 inches) wide and 20 centimeters (cm) deep. Soil around the inefficient rain collectors and the

general surface of plots showed no evidence of rain.

Dr. Kirk counted the rootworm eggs around 10 randomly selected plants in each group the following week. He found 17 times as many eggs around efficient collectors as around the inefficient ones. All the eggs were on the faces of soil cracks and 2.5 to 5 cm (1 to 2 inches) below the surface—well above the general level of moist soil in the field.

Corn rootworm adults prefer to lay eggs in moist soil, in cracks leading to moisture, and at the bases of corn plants. The correlation of this information with rain-collecting efficiency of different plants had not been documented before Dr. Kirk's study. He is part of a team that, in cooperation with the South Dakota Agricultural Experiment Station, is seeking ways to control the corn rootworm.

Alcohol and soybeans

FLAVOR of soy protein can be improved by steeping or wet milling the whole soybeans with aqueous ethyl alcohol. Commercial use of the procedure could lead to further expansion of growing markets for soy protein used in foods, say ARS chemists of the Northern Regional Research Laboratory, Peoria, Ill., (NRRL).

The alcohol treatment reduces flavor intensity of soybeans, leaving a slightly cereal taste. The blandness could enable food processors to increase the amount of soy proteins they use without changing the flavor of foods to which the proteins are added.

Chemist Arthur C. Eldridge, who led the soybean processing experiments, said a taste panel rated full-fat flour from steeped soybeans with a score of 7 on a 10-point scale in which 1 was strong and 10 was bland. The panel gave a 3.6 rating to untreated samples. Flavor intensity was reduced most effectively by aqueous alcohol with concentrations of 40 to 60 percent.

This range of concentrations also reduced activity of the enzyme, lipoxygenase, in the flour to less than 1 percent of the activity in flour made from untreated beans. If left unchecked, lipoxygenase may play a role in generating grassy-beany or bitter flavors after the seed structure is disrupted in processing, other studies by NRRL chemists have shown.

Steeping the whole beans with aqueous alcohol for 24 hours at room temperature improved flavor more than did wet milling them into an alcohol slurry. The researchers removed unabsorbed alcohol from the whole beans or slurry by low-temperature vacuum evaporation.

While the procedure inactivated nearly all the lipoxygenase in full-fat flour from treated soybeans, activities of soybean trypsin inhibitor and the enzyme, urease, were reduced respectively to 67 and 12 percent of the levels found in untreated flour.

Because of residual activity of soybean trypsin inhibitor and urease, Mr. Eldridge says conventional steam treatment of soy products may still be needed to insure maximum nutritive value for consumers.

Participating with Mr. Eldridge in the study were research leader Walter J. Wolf and home economist Kathleen A. Warner.

Ozone and metabolism

PLANTS exposed to air pollution may break down pesticides differently than plants that are not. The amounts and kinds of principal end products (metabolites) may not be the same.

The proportion of specific metabolites of the herbicide diphenamid was markedly altered, in studies at the Metabolism and Radiation Research Laboratory, Fargo, N. Dak., when tomato plants were fumigated with low levels of ozone. Exposure to this pollutant had little effect on root absorption, translocation, or the conversion of diphenamid to water-soluble metabolites.

ARS plant physiologist Richard H. Hodgson says the significance of altered diphenamid that had been labeled with of ozone is still to be determined. Other environmental factors are known to influence the effectiveness of herbicides in weed control.

Dr. Hodgson conducted the studies in a controlled environment, using diphenamid that had been labeled with carbon–14 as an aid in monitoring uptake and metabolism. Some of the tomato plants were prefumigated with ozone for 15 to 20 hours, and fumigation of these plants continued during the 22 to 29 hours when diphenamid was supplied in the nutrient solution to both fumigated and control plants.

Diphenamid is normally metabolized in tomato plants by bonding to glucose to form a beta-glucoside in the first 24 hours, Dr. Hodgson says. Tomatoes that had been fumigated with ozone did not form the normal amount of the beta-glucoside. Instead, the predominant metabolite found in the first 24 hours was another sugar end product, which Dr. Hodgson and colleagues identified as the beta-gentiobioside.

The ratio of beta-glucoside to beta-gentiobioside was 8.2 to 1.0 in nonfumigated tissue but 0.6 to 1.0 in tissue from plants exposed to ozone.

Dr. Hodgson and colleagues later found that beta-gentiobioside accumulated in unfumigated tomato plants only after 4 days. Ozone fumigation apparently stimulated production of this metabolite in tomatoes.

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Controlling sugar beet weeds

COMBINING HERBICIDES and certain mechanical measures provides a full-season program for controlling sugar beet weeds without harming the crop. Such a program reduces labor costs, increases production, and provides more flexibility in cultural operations.

A full-season weed control program gives farmers a 1-month period when sugar beets can be effectively and easily thinned with no weeds to consider. Without it, the thinning operation involves hand labor and poses time problems for growers. Critical weeding has to be done early while weeds are still small and manageable.

In employing the control program, ARS agronomist Jean H. Dawson, Irrigated Agriculture Research and Extension Center, Prosser, Wash., applies the herbicide cycloate to the soil at planting, phenmediphan to the surviving weeds after the beets have emerged but prior to thinning, and trifulralin to the soil shortly before or after thinning. Dr. Dawson uses the herbicides in conjunction with interrow and intrarow tillage.

Although recently developed mechanical thinners can replace hand labor for thinning, hand labor will still be necessary in moderate amounts if 100-percent weed control is desired. Many growers seek 100-percent control of weeds in sugar beets to prevent possible production losses, harvest complications, storage losses, and esthetic detraction caused by a few large weeds.

Minor, presently insignificant weed species tend to survive mechanical thinning. Unless these weeds are removed by hand they will go to seed and infest fields. Left unchecked, these minor weed species for which there are no controls, could become major weed populations which in 5 to 10 years would replace present, controllable weed populations.

Shipping grapefruit

RECENT STUDIES show that tray-pack Florida grapefruit suffered significantly less deformation than conventional place-pack fruit in export shipments to France and Japan.

The study, conducted by ARS agricultural economists Philip W. Hale, Orlando, Fla., and Lawrence A. Risse, Rotterdam, the Netherlands, included five export-shipping tests to compare deep-cell pulpboard tray-pack cartons with the conventional 4/5-bushel, place-pack cartons packed with Marsh grapefruit. Two shipments went to Le Havre, France, and three to Tokyo, Japan.

In the tests, containers were loaded into the refrigerated holds of ships in a normal manner—stacked in layers eight and nine high. The experimental cartons were placed in the lower three layers because those layers of cartons normally suffer the greatest damage.

Transit time from packinghouse to destinations ranged from 18 to 21 days for shipments to France, and from 29 to 31 days for shipments to Japan.

The percentage of grapefruit seriously deformed in the conventional place-pack cartons was about four times greater than that for fruit in the tray-pack cartons. Percentages of seriously deformed fruit were: size 32—tray-pack 15.4 percent, place-pack 58 percent; and size 40—tray-pack 13.5 percent, place-pack 59.6 percent.

The tray-pack cartons cost more in terms of packing materials, require more space in storage, transport vehicles, and ships' holds, and cost more to handle and ship than an equal amount of fruit packed and shipped in conventional place-pack containers.

The researchers point out, however, the grapefruit buyers and receivers interviewed in Europe and Japan insisted they would pay a premium for high-quality, well-shaped grapefruit.

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